The JPL Software Quality Improvement Project

Software Quality Improvement at JPL: What Does It Mean for Practitioners?

Presentation to the IT Symposium

November 4, 2002

Frank Kuykendall and the SQI Project Team

Agenda

- Why are we doing this?
- What are we doing?
- What does it mean for practitioners?

Key Motivators for Software Quality Improvement at JPL

- Experience and formal studies have revealed consistent budget overruns and schedule slips for mission-critical software
- Software is an increasingly significant risk element for a project
  - Missions require increasing software capability and complexity
  - Software often must be developed late in the mission life cycle, reducing opportunities for schedule recovery
- Many missions in concurrent software development
  - Institutional processes needed to reduce project start-up times
- Software practices must increasingly rely on re-use
  - Addressing complex software with aggressive budgets requires reuse of software implementing common functions
- The NASA CIO, Chief Engineering Office, and Office of Safety and Mission Assurance are requiring NASA centers to implement software quality improvement programs
- Caltech has expressed interest in software improvement at JPL

JPL Cost/Risk Study

- A 1999 study of software costs and risks for seven JPL projects found significant, specific issues in:
  - Project planning
  - Requirements & design
  - Experience and teaming
  - Testing
  - Software inheritance

CMMI-Based Software Assessment

- An assessment of software development practices at JPL was completed on October 22, 2002
  - Based on the Capability Maturity Model-Integrated (CMMI)
  - Examined four JPL projects
- Some strengths observed:
  - Evidence of strong JPL senior management commitment to software improvement
  - Projects appear supportive of process improvement efforts
- Some areas where opportunities for improvement were observed:
  - Software quality assurance
  - Planning of development processes by projects
  - Monitoring and control of process activities
  - Measurement of project products and processes
  - Risk management

Example Business Benefits of Improved Software Practices

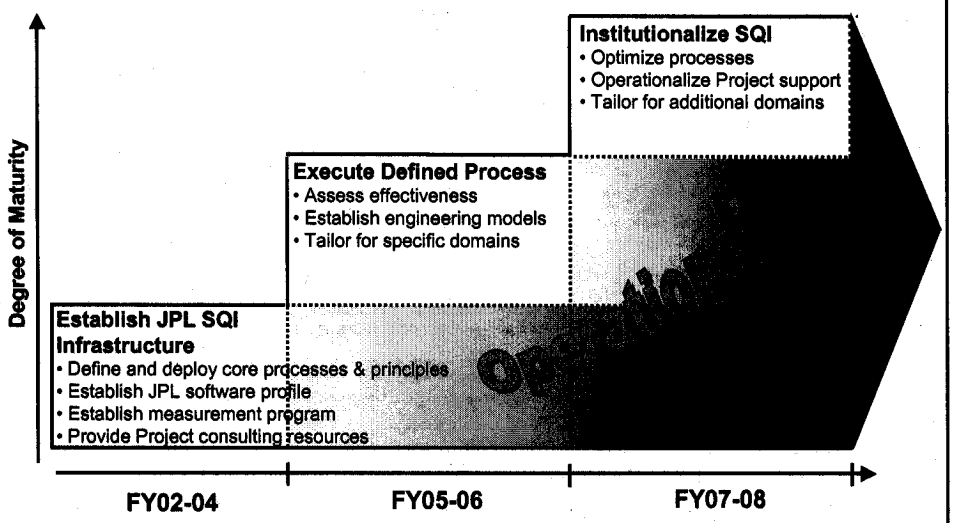
Organization	Payoff Summary	Reference
Boeing Info. Systems	Project estimates within 20% using historical data, CPK 38% better, defect containment effectiveness at 80%, cycle time improved 36%, staff support needs down 62%, staff size reduced 31%, customer satisfaction score up10%, $5.5M saved in 1996 alone (1992 – 1996 results)	Vu, J. (1997)
Boeing STS	Customer satisfaction rated excellent, pre-release defect containment effectiveness at 98%, 31% reduction in rework-inspections benefit, employee satisfaction level from mean of 5.7 to 6.3, operational systems performance close to bull's-eye, level 5 process injected into new programs	Yamamura, G. & Wigle, G. (1997)
Bellcore	Defects 10X lower than industry average, customer satisfaction rates improved from 60 to 91% over 4 years, achieved 9 hr. cutover to add 888 to 800 system with no reported defects.	Bellcore Press Release, Feb. 5, 1997
HP EESD	3X3 SPI program, 1 year benefits include: cycle time reduced by 33%, major open defects reduced from 4.6 to 1.8, fewer missed deadlines, ROI 9:1	Lowe & Cox (1996)
Harris ISD DPL	2.5X productivity gain over norm, 90% defect rate reduction, cycle time down to 6-9 months	Robeson, D., Davidson, S. & Bearden, L. (1997)
Motorola	3X productivity improvement, 3X cycle time reduction, 7X quality improvement, results from '92-'96 representing 85% of all products & released software, 75% of product development orgs. Are at level 3	Major, J. (1996)
Motorola GED	On 34 current programs compared to baseline – each CMM level increases quality by 2X, significant decreases in cycle time as higher levels reached (2-7X), productivity increases of 2-3X at highest levels of maturity, 6.77X SPI ROI	Diaz, M. & Sligo, J. (1997)
SAIC Health Tech.	50% improvement in customer satisfaction, 71% reduction in error rate, 12% annual improvement in developer productivity, production rate up 30%	Lane, J. & Zubrow, D. (1997)

SQI Project Goal & Objectives

Establish an operational program that results in the continuous, measurable improvement of software quality at JPL

- Improve software cost and schedule predictability
- Reduce software defect rates during test and operations
- Increase software development productivity
- Provide an infrastructure that promotes software reuse
- Reduce project start-up times

SQI Implementation Phasing



Key FY02 Accomplishments

- Formed Software Engineering Management Oversight Group (SEMOG)
- Engaged senior management and obtained buy-in
- Completed & signed SQI Initiation Plan; developed draft detailed Implementation Plan
- Aligned with NASA Software Working Group (SWG)
- Developed a profile of JPL software
- Completed Corrective Action Notice (CAN) 168
- Developed an initial set of SQI core assets, *e.g.*
  - Developed *FP Practices*, *Software Design Principles*, *Software Development Requirements*, handbooks, and templates
  - Created costing and metrics approaches, models, & documents
  - Expanded Software Tool Service (STS) support to projects for software license acquisition and tool demonstrations
  - Created and delivered many software courses, modules, & briefings; established JPL software web site
- Provided consulting and other services to projects

SQI Project Thrust Areas

Process & Product Definition (PPD)

Capture, define, and refine repeatable processes and a set of engineering practices for project use

Measurement & Benchmarking (M&B)

Provide measurement infrastructure for projects,conduct empirical analyses, and package experiences for future use

Project Engineering

Provide overall technical infrastructure and thrust integration

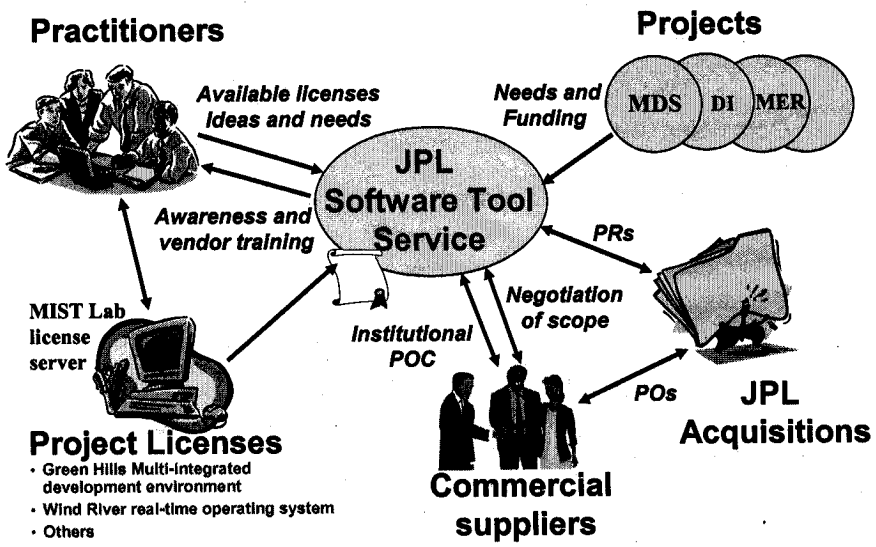
Software Technology Infusion (STI)

Identify, evaluate, and support software tools and techniques to facilitate process and product improvement

Deployment

Infuse practices into project use; provide training, products, mentoring and consulting for projects

The Software Tool Service



FY03 Plans in Brief

- Define and measure success criteria
- Define, collect, and analyze measurements of current practices, products, and SQI asset utilization
- Work with senior management to plan & implement new improvement opportunities

Primary focus is on mission-critical software – others supported as resources permit

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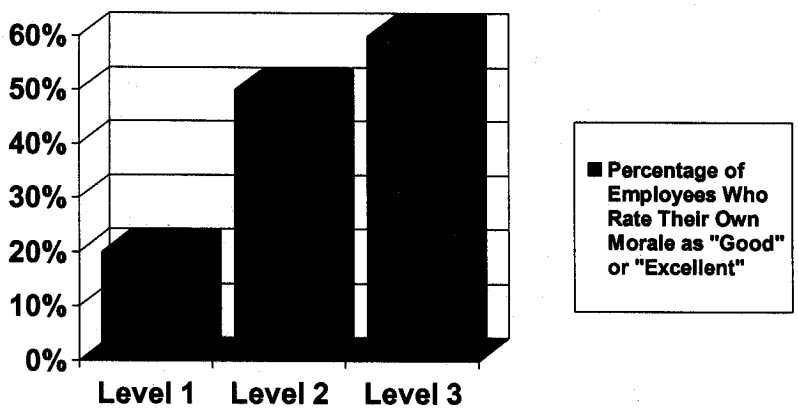
- Provide consultation on project planning (*e.g.*, cost estimation; metrics definition, collection & analysis)
- Operate focus groups to support users
- Provide training and consultation on use of SQI-produced artifacts and services

…t Development Deployment

- Collect cost data and establish cost data base
- Complete a set of SW engineering models that support project planning
- Deliver training to support new institutional requirements (*e.g., SDR*)
- Produce additional document templates & handbooks, based on needs
- Expand SW tools services
- Operate JPL SW website

Practitioner Experiences: Enhanced Morale



Source: James Herbsleb et al, "Software Quality and the Capability Maturity Model," CACM, June 1997

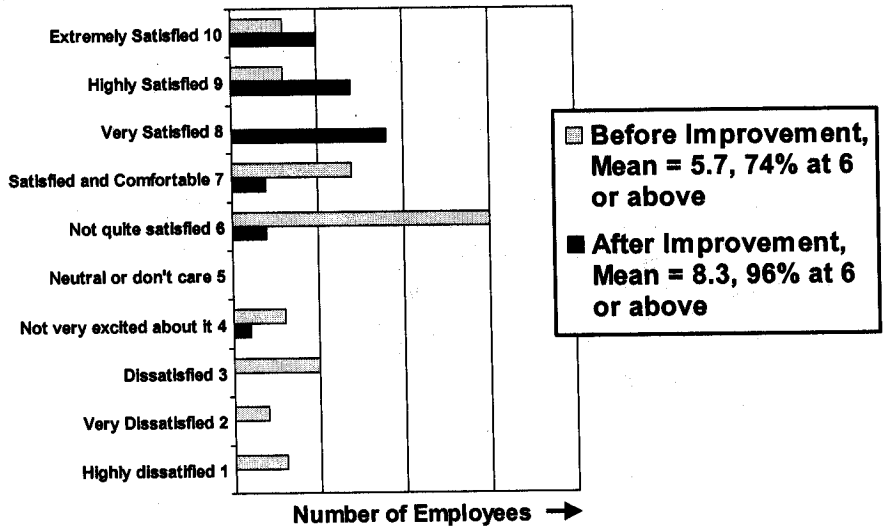
Practitioner Experiences:

Ogden Air Logistics Center, Software Engineering Division

Survey Question to Practitioners Who Had Been in CMM-Based Process Improvement Effort for Its Duration	Responses (n=18)	
Have you been more constrained or less constrained in performing your job?	More constrained: No difference: Less constrained:	10 4 4
Is it easier to perform your duties with respect to tools, working environment, etc.?	Much easier: A little easier: About the same: A little harder:	13 2 2 1
Are there more project surprises or fewer?	Fewer: No difference: More:	13 4 1
Do you feel that you have more input and control into project planning or less?	More: A little more: Same: Less:	12 2 2 2
Do you feel that our CMM efforts have been a positive influence?	Yes: No:	18 0
Do you feel you are producing better quality software?	Has improved: Always was good:	16 2

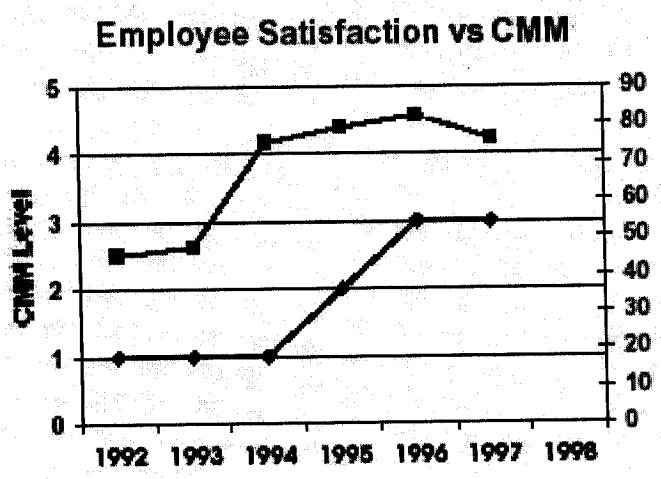
Source: Leon G. Oldham et al, "Benefits Realized from Climbing the CMM Ladder," Crosstalk, May 1999

Practitioner Experiences:
Boeing Space Transportation Systems (CMM Level 5)



Source: George Yamamura, "Process Improvement Satisfies Employees," IEEE Computer, Sept./Oct. 1999

Practitioner Experiences:
Ericsson (CMM Level 3)



Source: Hans-Juergen Kugler, "Is Software Engineering Feasible?", 1997

Potential Benefits and Drawbacks for Practitioners at JPL

- More reasonable and predictable schedules
- Less stress
- Ability to produce better products
- Less rework
- Earlier detection of defects
- Higher productivity
- Easier transitions from project to project
- Better interactions within and among teams
- Faster start-up of projects
- Less freedom in creating processes
- Increased need for documentation
- More scrutiny in use of defined processes
- More peer review of work products
- Increased need to produce measures of performance
- Higher expectations from management

For Further Information

- Attend upcoming panel discussion with practitioners from software organizations with high-maturity processes
  - Tentatively planned for mid-December or mid-January
- Visit the JPL Software web site:
  http://software
- Contact the Software Quality Improvement Project:
  - Frank Kuykendall, Project Manager, x32828
    - Frank.Kuykendall@jpl.nasa.gov
  - Trisha Jansma, Deployment Element Manager, x40647
    - P.A.Jansma@jpl.nasa.gov